American Meteorological Journal.

A Monthly Review of Meteorology
—AND—
Allied Branches of Study.

Vol. I. AUGUST, 1884. No. 4.

CONTENTS.

Entered at Detroit Post Office as Second-Class Matter.

W. H. BURR & CO., DETROIT, MICH.
F. A. BROCKHAUS, - LEIPSIG, BERLIN AND VIENNA.

Single Copies, 25cts. - Per Annum, $3.00.
In European Countries, $3.25.

M

V

M

co
to
F
I
ti
co
d

S

T
n
S
n
n
in
n
li
n
th

THE AMERICAN

Meteorological Journal.

VOL. I. DETROIT, AUGUST, 1884. NO. 4.

EDITORIAL NOTES.

METEOROLOGISTS will find cause for congratulation in the establishment of the Corcoran School of Science and Art in connection with the Columbian University. Among other instructors we find Mr. Cleveland Abbe, lecturer on meteorology, and Mr. Frank Waldo, instructor of practical and mathematical meteorology. Instruction in this science should be more general, and we hope the time is not far distant when it will form a part of the work in every college. It should make a part of all elementary instruction, and, doubtless, that will come in time.

SEVERAL letters have reached us concerning the foundation of a meteorological society, and all are favorable, some enthusiastic. The general opinion seems to be that the society should be in connection with the American Association for the Advancement of Science—as a subsection. We think all those interested in the movement should make an effort to be present at the Philadelphia meeting (September 4–10). Such a society or subsection should include all the branches of meteorological interest, sanitarian, climatological, agricultural and practical. As such a subsection must live on papers, those who propose to be present should bring as many valuable papers with them as possible, and thus demonstrate the necessity of the subsection.

CONGRESS has appointed, according to the daily press, a joint committee to inquire into the organization and work of the principal scientific services of the Nation. The first meeting of the committee will be in Washington, November 17. Meantime sub-committees are to collect separately information concerning the services. Senators Allison and Pendleton will investigate the Signal Service; Representatives Lowrey and Lyman the Coast Survey and the Geological Survey; Senator Hale and Representative Herbert the Hydrographic Office. All these services are very creditable to our national reputation. They have done, and are doing, good work, and they have the respect of competent judges the world over. They are doing, on the whole, as good work as is done anywhere. The chief thing they require is, to be given a sufficient income. They can then be left to work out their own destiny. The guarantee that their work will continue to be creditable is to be found in the honor and ambition of those who have charge of them, and in the criticism of the general scientific public. We would especially deprecate any change of the Coast Survey from its present connection with the Treasury Department. It has done pre-eminent work where it is, and the opinion of its best friends (including its own superintendent) is against any transfer.

OF the discovery and return of the Greeley party our readers have been sufficiently informed by the daily press. The enterprise itself was so daring, it was carried through with so much pluck, the sacrifice of life was so great, and the success in the scientific objects of the expedition so complete, that it has attracted universal attention. There are however some additional comments that can properly be made.

The great loss of life was not a necessary part of the undertaking. The fatality occurred after the scientific work of the party was completed. The residence of two years within ten degrees of the pole was safely performed without hardship so excessive as to be fatal and it can be repeated when necessary. The fatality occurred in leaving the station and could have been prevented if we had known as much in 1881 as we know now. The prevention will be a simple matter; it is simply a question of the amount of supplies to be left at the station and along the path of the retreat.

At the same time, while we can see now how to have prevented the sad loss of life, it should be remembered that "hindsight" is better than foresight. The preparations for the station were made

with extreme care and those who now say, "I told you so", should have told us so before the party started. With what we know now residence at Lady Franklin Bay could be made about as safe as any where else.

It is too early to discuss the scientific results of the station, but from what is already published, we see no reason why the next party at Lady Franklin Bay should not be provided with a means of investigation which has been much discussed lately and that is—the balloon. While it could hardly be made the means of transportation, by means of it favorable opportunities may be embraced for an elevated station from which birds-eye views could be easily obtained. Besides it could be employed for investigating a vertical section of air and that in so high a latitude would be of extreme interest.

Of those to whom the expedition proved fatal, the writer of this note knew only Edward Israel. He was a brilliant young man who stood easily at the head of his fellow students in college. Not only was his mind unusually bright and active, but he was well developed physically and had some reputation as a college athlete. Moreover his was an unusually amiable and attractive disposition. With sufficient wealth to have enabled him to pass his life in ease, he chose physical science as his pursuit and deliberately accepted, with a full knowledge of its dangers, an appointment under Lieutenant Greeley, because he considered it a good opening for a career in his chosen field of study. In his decease science has lost a votary of unusual promise.

CURRENT NOTES.

A NEW plan for a polar expedition has been submitted by several officers of the Russian Navy to the Minister, Admiral Shestakoff. Starting with the conviction that it is impossible to reach the North Pole by sea on account of the islands that surround the polar region, the Russian officers propose to start an expedition in sledges from the New Siberian Islands, which are 900 nautical miles distant from the goal. This space is to be covered by sledge parties, who would make depots of provisions in the newly discovered islands and thus slowly but surely advance toward the north, securing at the same time the return journey of the expedition. When elaborated, the scheme will be submitted to the learned societies of Russia and the necessary funds raised, partly by subscription, though it is probable that, if the Government approves it, it will advance at least part of the expenses.—*Scientific American.*

MR. HENRY G. VENNOR died recently in Montreal. He was born in that city in 1841 and was connected with the Canadian Geological Commission from 1865 to 1880. In 1870 he was made fellow of the Royal Geological Society, before which society several of his papers were read. He began his weather-predictions in 1875. What he considered his discovery was the cyclical return of the weather in short periods, and he seems to have become so enamored with the theory that he was incapable of employing in it the scientific acuteness which he displayed in other fields. It is perhaps easier to deceive ones self and gain notoriety in weather-forecasting than in any other field of scientific inquiry.

A SOCIETY has recently been formed in Boston, to be known as the New England Meteorological Society, for the study of the weather and climate of New England on the basis of records made by local observers at a number of stations within that region. At the outset, a relatively limited system of observations will be undertaken, probably not going beyond rainfall and range of temperature, until the society is well established and the observers numerous and practiced in their work. It is desired, also, not to undertake more than can be discussed satisfactorily by those in charge of the work. There is already a good number of stations where certain meteorological records are kept, as at the various waterworks, hospitals and observatories, as well as at the regular Signal Service stations and in many private establishments. It is hoped that these may all be brought into coöperation, whereby the value of their observations will be greatly augmented; and their number should be largely increased by the enlistment of observers from among school teachers, light-house keepers, and many others, the regularity of whose occupations would be in no wise interfered with by the taking of one or two daily observations. Membership is also open to all persons who feel an interest in the observational study of meteorology and who desire to encourage its further development. The control of the society's business is placed in the hands of a council of five, consisting of Prof. W. H. Niles, of the Mass. Institute of Technology, president; W. M. Davis, of Harvard College, secretary; D. Fitz-Gerald, of the Boston waterworks, treasurer; E. B. Weston, of the Providence waterworks; and Prof. Winslow Upton, of Brown University, director of observations. Early in the fall the council hopes to issue monthly bulletins containing a summary of observations. All persons interested in the success of the society are requested to send their names to the secretary, at Cambridge, Mass.

DR. ANGUS SMITH died May 12th at the age of 67 years. His studies on the composition of the air are well known, and his work on *Air and Rain* is an indispensable part of every meteorological library.

WE have Duboscq's catalogue of apparatus and accessories for the photographic registration of atmospheric electricity and magnetism. His address is 21 rue de l'Odéon, Paris. He makes Mascart's registering instruments. His retail price for a complete electric outfit is somewhat less than $300. The most expensive piece is the register which costs 580 francs ($116.) His magnetic outfit costs between $500 and $600.

ON the night of Jan. 20–21., Rev. P. B. Fisk, field agent of Carleton College, landed from a delayed train at Minneapolis. It was not far from the hour of 4:30 A. M., and, in the over-crowded state of the hotels, and the entire absence of conveyances, at that hour, and in the intense cold, he was obliged to walk nearly half across the city to the house of a friend. On looking up at the moon, a very singular phenomenon met his eye. The sky appeared to be cloudless, and only a very few stars appeared. The moon was nearly at the full, and appeared riding in a halo of frost. There was a large circle about it, taking in most of the stars which were visible in the west, one of which, near the circle on the right of the moon, was a planet, but this circle was not equally distinct throughout so much of its circumference as appeared above the horizon. Directly above the moon, and on either side of it, this circle was ornamented with bright spots almost as large, and almost as bright as the moon itself, while wings of bright rays shot from them on both sides coincident with the circle, and at right angles with these on the outside of the circle. About one-fourth of the circumference of the circle was cut off by the horizon, but, just where the fourth ornament should have been, there was a luminous appearance of the sky immediately on the horizon. The rays shooting off from these luminous spots were not of equal length, or distinctness, but the longest of them must have exceeded three apparent diameters of the moon itself.

This grand display began to fade almost as soon as noticed, and in twenty minutes after the observer arrived at his stopping place, nothing but a haze slightly more luminous than the sky in general marked the place where all this view had been displayed above a sleeping city.

Mr. E. Stone Wiggins has made a wonderful discovery and his method of making it is more wonderful than the discovery. Discovery and method are given in a letter dated June 3rd and addressed to the New York *Tribune*. The discovery consists in one or more invisible moons, the exact number of which the discoverer does not seem to consider important. We regret to deprive Mr. Wiggins of priority, but a dark moon has long been known to the Chinese. Its theory was developed to us by the Chinese philosopher and friend whose attention to our gastronomic wants and the polish of our shoes made our residence in Peking much more agreeable than it could have otherwise been. According to this philosopher, the dark and bright moon were connected and eclipses and phases were caused by the motions of the two relative to our line of sight. Our philosopher and friend treated the popular delusion of a dragon in the sky as the cause of eclipses, earthquakes and weather with the contempt which doubtless Mr. Wiggins also has for it.

The method of making the discovery is characterized by extreme simplicity. It consists in creating a hypothetical cause for phenomena and, when the cause and phenomena do not agree, in varying the cause until they do. Thus, Mr. Wiggins assumes that weather and earthquakes depend on the moon and, when the moon will not do the work required of it, he freely adds another moon or two. Evidently the method is capable of indefinite expansion; a hundred invisible moons can be added if necessary, and with these he can account for anything. The simplicity and adaptability of this method need no further illustration. We note that an additional advantage is that it disposes of all the anxious labor and worry which most scientific investigators have to go through in adjusting their theories to known principles. We proceed, with sincere regret, to deprive Mr. Wiggins of the right of priority to his method. The fact is that it has been employed by operators of his class from time immemorial. But, though he loses his priority in discovery and method, he can not be deprived of the colossal imagination nor of the heroic contempt for logic, which are displayed with unmistakable clearness in his whole letter and in his previous publications, and his graceful disregard of the usually accepted principles of science are worthy of our highest admiration. We venture to suggest that Mr. Wiggins investigate the Chinese celestial dragon, for unlike a moon, which is an undifferentiated sphere, he (the dragon) has two jaws, four legs and a tail, and we think by proper combina-

tions and permutations of these organs, Mr. Wiggins could account for all phenomena without the new moons and perhaps could dispense with the luminous satellite now generally believed in by other people.

THE following circular is addressed to the county surveyors of Minnesota. We trust Professor Payne's efforts will meet with the best success.

CARLETON COLLEGE OBSERVATORY. — State Magnetic Survey.

Northfield, Minn., June 15th, 1884.

Dear Sir—The Director of the Observatory at Carleton College, Northfield, Minn., has, for some time, contemplated a Magnetic Survey of the State of Minnesota, by counties, for local, scientific, and Coast Survey uses. By arrangements recently made with the Superintendent of the United States Coast and Geodetic Survey, at Washington, D. C., this important work can now be undertaken on the part of the Director of the Astronomical Observatory at this place, and the preliminary part of it can be completed before September, 1885.

The preliminary part, which should be done as soon as possible, consists in establishing an accurate meridian line in each county in the State, where official co-operation can be assured. These meridian lines will be set by solar or star observations with instruments and methods approved by the Superintendent of the U. S. Coast Survey; and at such places in counties (one in each) as shall be designated by the County Surveyor. These meridians are to be suitably and permanently marked according to the directions of the above-named Government officer.

It should be clearly understood that this work is not undertaken in the private interest of any person or corporation, but simply for the advancement of science and the public good, and therefore no compensation for services is expected. Inasmuch as there is no money appropriated by the general government for this purpose, it is hoped and believed that the respective counties of the State will assist in defraying the actual expenses incurred in this work, which it is certain will not exceed fifteen dollars ($15.00,) per county, on the average for the entire State Survey. In view of this, County surveyors are respectfully asked to consider the proposition of co-operating with me in establishing in each county an astronomical meridian line, which shall be regarded by the State and the Government, as the standard magnetic meridian for such county; and if

surveyors deem the proposition a wise one, they are also respectfully asked to lay the matter before their respective Boards of County Commissioners, and advise favorable action thereupon, and to communicate the result to me as soon as possible.

The advantages to be gained by such a State Survey are briefly these:

1. A meridian line set by astronomical methods is more accurate in principle than a magnetic compas-line can be. In the case of doubtful surveys of almost any kind, the County Surveyor would have *one* standard meridian line for reference, that will be his authority, thereby avoiding, sometimes, needless litigation or differences of opinion, because all surveyor's instruments and claims would be subject to *one* standard The practical surveyor knows what it means to have meritorious authority, in easy reach, in all such cases; and the principle of this kind of check is a just and needful one for all parties interested.

2. Such a survey would be of great value to science, in helping to determine for all localities, the diurnal, irregular, and seasonal variation of the needle, and in time, would give most useful data in the study of the secular variations of the magnetic force, which has in all probability a period of more than a century. In this way each county meridian line would be recognized as a magnetic station, by the Government and the Chief of the State Survey, for an indefinite future time.

3. It is the purpose of the Superintendent of the Coast Survey, to select some of these county stations for series of complete magnetic differential observations to be taken annually, and to extend over a term of years, that the results may be known, and used in the official study of the magnetic force. To this end the Coast Survey Office will supply to the State Observer, the necessary instruments, both for the preliminary work, and the more complete work to be done subsequently.

4. This brief outline of what seems to me a highly important matter is respectfully commended to your favorable consideration, with the personal request that you notify me at your earliest opportunity, whether it seems wise to you to co-operate with me in carrying forward this State Magnetic Survey. Further correspondence is solicited.

Very Respectfully Yours,

CARLETON COLLEGE OBSERVATORY. } WM. W. PAYNE,
Northfield, Minn. } Director.

THE RELATION OF TORNADOES TO CYCLONES.

The accompanying figures give in a condensed form the relations of one hundred tornadoes to the four cyclones in which they took place. The figures are constructed after a method described by the writer in a recent number of *Science* (Apr. 4, 1884), of which the essential feature is the bringing together a number of isolated or separated phenomena on a single chart in their proper attitude with respect to some single controlling condition. Fig. 1 shows the form of the isobars (showing curves for every two-tenths of an inch), the

FIG. 1.

flow of the winds and the position of the tornadoes of Feb. 19, March 11 and 25, and April 1, 1884, with respect to the cyclone centres of those dates, taken from the 3 P. M. and 11 P. M. observations on Mr. Finley's admirable tornado charts, recently issued by

the Signal Service. The broken lines, extending about south by west from the cyclone centre, are added to mark the separation of the warm southerly winds and the cooler northwesterly winds. It must, of course, be understood that this separation is actually rather on an irregular belt of country than along a sharp and straight line; but the lines, as here drawn, separate all the recorded northwesterly and southerly wind observations on the several tornado charts; and their agreement in position is very satisfactory. The form of the isobaric curves is not at all constant; those of February 19 are strongly elongated north and south, while those of April 1 are extended east and west. The winds are somewhat more regular; and it is noteworthy that all the tornadoes, with perhaps one or two apparent exceptions, have occurred within the area of the warm surface winds from the south, although their course to the northeast is parallel to the supposed flow of the higher winds in the upper part of the cyclonic system; or, we may say, parallel to the direction that the northwesterly surface winds, of the southwestern quadrant of the cyclone, would attain if they continued in the ordinary storm-spiral course over the southerly winds of the southeastern quadrant. In plotting the tornadoes, which are shown by short heavy lines, care is taken to place the cyclone centre in its estimated position for the hour of their reported occurrence, and not simply in its position given by the three or eleven o'clock observations; but this cannot be accomplished with precision, because the hour of the tornadoes is not always closely stated. The division of the tornadoes into three groups may be partly subjective, and dependent on deficiency of observation in some of the thinly settled districts of Kentucky and Tennessee; but it is more probably in greatest part dependent on the topography of the central and southern States.

Fig. 2 represents the isothermal lines of the same set of charts. In this figure the line of separation between the warm and cold winds, instead of the cyclone centre, is taken as the directrix to which the other phenomena are referred; the change was made in order to determine which of the two methods of plotting would bring all the tornadoes into the smallest space, and the result seems to be slightly in favor of the latter method. The separation line and the isotherms are taken from the 3 P. M. charts, and then advanced to the positions they would reach at the times of the several tornadoes. The form and distribution of the isotherms give clear confirmation of the inference drawn from the relation of the tornadoes to the winds. The tornadoes are distinctly within the region

of high and nearly uniform temperature, and east or southeast of the crowded isotherms which show the district where the temperature falls rapidly.

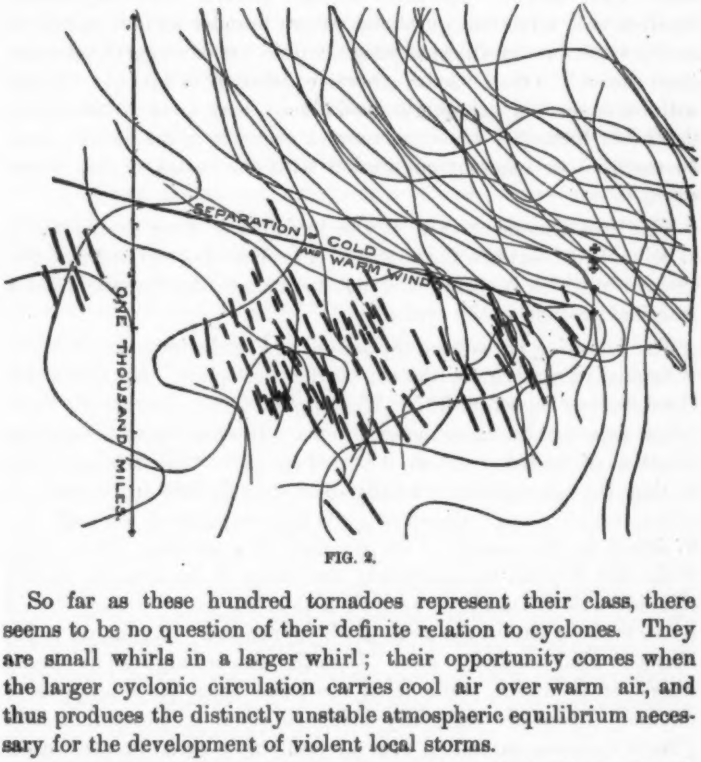


FIG. 2.

So far as these hundred tornadoes represent their class, there seems to be no question of their definite relation to cyclones. They are small whirls in a larger whirl; their opportunity comes when the larger cyclonic circulation carries cool air over warm air, and thus produces the distinctly unstable atmospheric equilibrium necessary for the development of violent local storms.

This relation has already been more or less distinctly perceived, as is noted below, but has never had such proof as it finds in Mr. Finley's tornado charts of this year.

In connection with Mr. Finley's tornado-studies the extract given below from a paper by Redfield is of interest as showing an early suggestion of the connection between tornadoes and cyclones that is now finding good proof. The paper referred to is "On three several hurricanes of the Atlantic, etc.," New Haven, 1846, and from p. 94 we quote the following statements. "The appearance of violent tornado-vortices within the body of a great storm is not new nor very infrequent." * * * "Two very violent tornadoes

appeared in New Jersey, in a general storm, on the 19th of June, 1835, moving in different, but nearly parallel paths, at an interval of several hours. These pursued the course of the higher current which then overlaid the great storm. Several other tornadoes, together with numerous gusts and severe thunder squalls appeared on the same day, in different places, within the compass of the same great storm." On p. 95 the general conclusion is given: "These with other cases which might be adduced, may serve to show that the small tornadoes which sometimes occur in great storms have no essential or inherent connection with the vortex of the larger storm."

This last statement evidently is intended to deny the necessity of coincidence between the centre of a tornado and the *centre* of the cyclone in which it occurs, and not to exclude the tornado from a marginal position in the cyclone.

The following notes from the second of Ferrel's important "Meteorological researches for the use of the coast pilot," Appendix 10, Coast Survey report for 1878 (Washington, 1880), bear on the theoretical aspect of the same investigations. In speaking of the regular direction of tornado-rotation, it is said (p. 72): "The reason of this is that the atmosphere is hardly ever entirely free from cyclonic action, which, though almost or quite imperceptible, is yet sufficient to determine the manner of the gyrations of a tornado; for, in order to do this, it is not necessary that the center of the tornado should coincide with the center of cyclonic action, but simply that it should be somewhere within the areas of the gyrations." Again, on p. 93, blasts of wind are said to arise "from the air running into numerous whirls, or gyrations, while it, at the same time, has a progressive motion. These are especially liable to occur in connection with general cyclones extending over a considerable area, for then, especially in the cloud region, the air is often in a state of unstable equilibrium, and on account of the gyrations of the cyclone the moments of gyration, with regard to any point in the cyclone, cannot generally be naught, and hence we have both conditions which are required for the formation of these whirls in the atmosphere. These may form small secondary cyclones, or tornadoes and waterspouts, or simply a slight whirling in the atmosphere of not much violence. These blasts are especially observable on the clearing-up side of a storm. This is the clear cold side, and, as the upper part of this is carried eastward faster than the lower, it overlaps the more central warmer part of the air below before it has time to

cool down by radiation, and thus there is produced a more rapid diminution of temperature with increase of altitude, and a state of unstable equilibrium in which these gyrations of the air readily originate."

Finally we may quote from Mr. Finley's own studies of the Kansas tornadoes of May, 1879 (Professional Papers of the Signal Service, IV, 1881), p. 109: "As an area of low barometer (not necessarily a storm area) advances to the Lower Mississippi Valley warm and cold currents set in towards it from the north and south respectively, which, if the low pressure continues about stationary for some time, ultimately emanate from the warm and moist regions of the Gulf and the cold and comparatively dry regions of the British Possessions. Here lies the key to the marked contrasts of temperature and moisture, invariably foretelling an atmospheric disturbance of unusual violence."

There has been some question of the possibility of cold winds rising to overflow warmer ones, and thus producing an unstable equilibrium in the atmosphere. It is, of course, to be admitted that such an action is unexpected and apparently unnatural; but there seems to be good reason for believing that it actually takes place. It remains for future investigation to show how and why it happens.

1. The most direct evidence of the rising of the cool northwesterly winds over the warm southerly, is the rather abrupt disappearance of the former from surface observation. The belt of separation between the warm and cold winds is well marked, and the isothermal lines stand almost parallel to it. The northwest or west winds hold their direction and retain much of their low temperature until close to the belt; and, on passing east of it, the southerly winds are encountered so suddenly, and with so pronounced a rise of temperature, that it is impossible to regard them as the continuation of the others. There is very small appearance of compounding, either in temperature or direction, about the separating belt. We must conclude that the cool winds have gone on as upper currents, above the warmer winds.

2. There is further evidence of a less observational, and more inferential character. If one imagine himself standing at the centre of a cyclone, endowed with the power of perceiving the courses of the winds on their normal inward and upward passage, he would see that the wind coming from any point on the horizon would rise as it approached the storm center and flow over the winds coming

from points farther to the left. On the northern side of the storm, warm winds would thus rise over the colder indrafts, and in the resulting steady equilibrium no local overturnings would occur. On the eastern or western side of the storm the resulting vertical distribution of temperature would not be especially abnormal; but on the south of the storm, and especially on the southeast, this ordinary cyclonic circulation would tend to carry the colder winds over the warmer, and produce unstable equilibrium. Here, if anywhere, tornadoes might be expected; and here they are found. They occur in this sector of the storm, but not in the other sectors. They are developed in groups. Their region of occurrence advances across the country at the same rate as the cyclone to which they belong. Thunder-storms and gusts of wind, not violent enough to be called tornadoes, but decidedly stronger than the ordinary wind of the cyclone, are reported in the same sector, and may be regarded as small or imperfectly developed tornadoes. The conjunction of all these peculiar conditions points very clearly to something abnormal in the local arrangement of the atmosphere.

3. Our cyclones are not ordinarily accompanied by tornadoes. That is, the adjacent indrafts are, as a rule, of moderate contrast in temperature, and, if their overflow require any rearrangement, it is of no great violence. But in those exceptional cyclones, whose irregular indrafts bring the cool dry winds of the northwestern plains into close contact with the warm moist winds from the Gulf, overturnings are developed of exceptional strength, and we know them as tornadoes. It is, perhaps, premature to say that all such cyclonic winds breed tornadoes; but it seems very probable that all our tornadoes are bred in such cyclonic winds.

The confirmation or disproof of these deductions from Mr. Finley's charts will be found in the later numbers of his invaluable series. They are not only of value in this special inquiry; they serve to teach the broader lesson of the importance of studying atmospheric movement as seen at one time from many places, instead of at many times from one place; for, in a medium so easily affected as the atmosphere, disturbances are seldom dependent on isolated causes, but are governed by wide-spread conditions; and local observation is too near-sighted to gain any adequate conception of what manner of mechanism is at work to bring about the changes it may witness. The tornado charts of the Signal Service, based on numerous observations in all parts of the

country, thus give ground for a close appreciation of the actual conditions of tornado formation. On the final charts, which, it is to be supposed, will succeed these that are marked "preliminary," still more numerous observations of wind and temperature may be hoped for, so as to show with even greater precision the relation of the tornadoes to their parent cyclones.

CAMBRIDGE, June 20, 1884. W. M. DAVIS.

NOTE.—Mr. Finley's reports of his results in *Science*, and a preceding number of this JOURNAL, published after the above article was written, show the great practical value of the relation that he has established between tornadoes and cyclones.

BAROMETER OBSERVATIONS, 1861–1884.

BY WM. DAWSON, SPICELAND, IND.

The observations from which the accompanying table has been deduced were commenced July 1st, 1861, about one mile south of Cadiz, Henry County, Indiana. I moved to Spiceland (same county), 8 miles S. S-E. of Cadiz station in March 1863. The latitude and Longitude of Spiceland are, approximately, 39.° 50′ and 85.° 25′. The barometer is a mercurial standard, No. 1416, by James Green, New York. The cistern was about 8 feet above ground at Cadiz Station, and 13 feet high at Spiceland, but was moved to another room 15 feet high, July 25, 1878. Observations have been made at 7 A. M. and 2 and 9 P. M. The observations for March 1863 were lost. Those of April, 1863, and Dec., 1862, were not regular. Most other months were nearly full—many *entirely* so.

My adopted altitude above sea-level has been obtained by taking the mean of three reported altitudes by R. R. surveys, viz: 1083, about 1075 and 1052, which comes out 1070 feet; and the barometer cistern is 5 feet higher than the R. R., giving 1075 ft. for its altitude. This with my mean temperature of 50 requires 1.16 inch to be added to my observations for reduction to sea-level, by which I get 30.08 inches for the mean of *nearly* 23 years; which, curiously enough, is the mean of the two extremes, 29.01 and 31.15.

MONTHLY MEANS AND EXTREMES

By William Dawson,

	January.			February.			March.			April.			May.			June.			July.		
	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.
1861																			30.10	30.34	[illegible]
1862	30.11	30.57	29.62	30.09	30.50	29.46	29.89	30.27	29.41	30.09	30.35	29.58	30.06	30.34	29.68	30.05	30.30	29.71	30.07	30.42	29.8
1863	30 09	30.59	29.46	30.16	30.58	29.52				30.05	30.42	29.61	30.08	30.34	29.60	30.05	30.21	29.82	30.07	30.30	29.8
1864	30.11	30.51	29.76	30.08	30.62	29.51	29.93	30.33	29.40	29.95	30.25	29.58	29.96	30.22	29.67	30.10	30.28	29.74	30.12	30.31	29.5
1865	30.11	30.64	29.68	30.07	30.43	29.48	30.01	30.36	29.41	30.08	30.55	29.67	29.99	30.30	29.71	30.09	30.24	29.85	30.10	30.32	29.6
1866	30.18	31.15	29.52	30.19	30.64	29.73	30.13	30.47	29.51	30.03	30.36	29.48	29.97	30.24	29.34	30.02	30.29	29.64	30.09	30.32	[illegible]
1867	30.03	30.52	29.29	30.05	30.68	29.20	30.08	30.47	29.61	29.99	30.30	29.63	29.96	30.31	29.50	30.05	30.29	29.68	30.09	30.20	29.8
1868	30.10	30.75	29.46	30.18	30.73	29.80	30.03	30.45	29.05	30.03	30.44	29.34	29.93	30.21	29.54	30 11	30.27	29.88	30.07	30.25	29.8
1869	30.04	30.34	29.61	30.00	30.48	29.35	30.09	30.52	29.56	29.99	30.39	29.35	29.93	30.22	29.48	30.06	30.37	29.56	30.07	30.32	29.9
1870	30.06	30.57	29.42	29.97	30.34	29.27	29.98	30.50	29.01	30.03	30.35	29.71	30.01	30.28	29.46	30.04	30.31	29.70	30.05	30.24	29.8
1871	30.15	30.42	29.65	30.04	30.50	29.30	29.97	30.33	29.58	29.90	30.41	29.48	30.05	30.26	29.75	30.03	30.24	29.81	30.06	30.29	29.8
1872	30.11	30.46	29.55	30.01	30.57	29.57	30.06	30.51	29.37	30.05	30.40	29.52	30.05	30.38	29.52	30.06	30.28	29.78	30.06	30.21	29.8
1873	30.03	30.40	29.40	30.04	30.49	29.62	30.06	30.61	29.58	29.96	30.24	29.43	29.98	30.30	29.62	30.04	30.37	29.68	30.11	30.35	29.8
1874	30.14	30.74	29.63	30.14	30.60	29.57	30.09	30.58	29.53	30.07	30.47	29.60	30.05	30.34	29.72	30.07	30.35	29.78	30.10	30.30	29.5
1875	30.11	30.57	29.80	30.13	30.61	29.66	30.04	30.43	29.40	30.04	30.36	29.66	30.03	30.57	29 23	30.06	30.30	29.90	30.07	30.37	29.8
1876	30.15	30.59	29.50	30.12	30.63	29.44	30.08	30.50	29.43	30.06	30.43	29.64	30.06	30.35	29.53	30.01	30.18	29.66	30.10	30.24	29.8
1877	30.17	30.49	29.52	30.19	30.63	29.67	30.05	30.38	29.32	30.00	30.43	29 46	30.09	30.35	29.70	30.04	30.20	29.77	30.06	30.28	29.7
1878	30.06	30.58	29.60	29.96	30.46	29.39	30.00	30.28	29.50	29.85	30.16	29.48	30.01	30.26	29.76	30.03	30.25	29.65	30.07	30.22	29.6
1879	30.15	30.42	29.76	30.11	30.50	29.58	30.12	30.52	29.68	30.04	30.44	29.53	30.09	30.42	29.69	30.06	30.34	29.61	30.06	30.25	29.7
1880	30.10	30.52	29.56	30.10	30.67	29.62	30.14	30.41	29.27	30.03	30.39	29.64	30.09	30.42	29.74	30.06	30.33	29.65	30.09	30.21	29.8
1881	30.13	30.61	29.50	30.12	30.52	29.39	30.08	30.31	29.27	30.02	30.37	29.60	30.07	30.33	29.88	30.00	30.22	29.69	30.09	30.31	29.5
1882	30.16	30.60	29.68	30.07	30.49	29.44	30.09	30.54	29.53	30.07	30.35	29 50	30.03	30.38	29.68	29.98	30.22	29.65	30.10	30.33	29.8
1883	30.14	30.54	29.49	30.26	30.69	29.67	30.05	30.48	29.55	30.01	30.31	29.65	30.02	30.36	29.65	30.01	30.33	29.65	30.10	30.34	29.7
1884	30.17	30.64	29.67	30.05	30.48	29.44	30.05	30.41	29.45	29.97	30.23	29.31	30.01	30.36	29.68						
Means and Extremes	30.11	31.15	29.29	30.09	30.73	29.20	30.04	30.61	29.01	30.01	30.55	29.31	30.02	30.51	29.28	30.05	30.38	29.56	30.06	30.48	29.6

OF BAROMETER, 1861—1884.

SPICELAND, INDIANA.

August.			September.			October.			November.			December.			Year.			
Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	
30.12	30.30	29.74	30.14	30.52	29.76	30.10	30.47	29.68	29.99	30.33	29.61	30.23	30.66	29.74				1861
30.14	30.38	29.90	30.16	30.33	29.79	30.16	30.50	29.94	30 12	30.60	29.67	30.18	30.67	29.68	30.09	30.67	29.41	1862
30.13	30.40	29.80	30.17	30.47	29.79	30.11	30.53	29.66	30.09	30.53	29.72	30.11	30.52	29.47	30.10	30.59	29.46	1863
30.04	30.25	29.80	30.06	30.30	29.79	30.02	30.34	29.70	30.04	30.44	29.42	30.00	30.60	29.47	30.03	30.62	29.40	1864
30.13	30.34	29.81	30.15	30.33	29.89	30.08	30.37	29.73	30.14	30.53	29.50	30.11	30.65	29.55	30.09	30.65	29.41	1865
30.07	30.32	29.86	30.09	30.36	29.80	30.15	30.51	29.62	30.09	30.63	29.54	30.08	30.43	29.37	30.09	31.15	29.34	1866
30.07	30.33	29.88	30.15	30.37	29.98	30.15	30.53	29.63	30.08	30.52	29.49	30.07	30.54	29.58	30.06	30.68	29.20	1867
30.11	30.36	29.81	30.11	30.42	29.77	30.17	30.57	29.77	30.12	30.43	29.79	30.11	30.47	29.51	30.09	30.75	29.05	1868
30.13	30.33	29.88	30.20	30.40	29.95	30.11	30.47	29.74	30.03	30.42	29.20	30.15	30.57	29.64	30.07	30 57	29.20	1869
30.08	30.32	29.86	30.14	30.32	29.87	30.12	30.47	29.62	30.11	30.47	29.73	30.07	30.56	29.28	30.05	30.57	29.01	1870
30.04	30.21	29.75	30.19	30.54	29.94	30.13	30.41	29.87	30.08	30.46	29.49	30.10	30.57	29.53	30.06	30.57	29.30	1871
30.13	30.31	29.92	30.08	30.34	29.86	30.14	30.45	29.75	30.12	30.54	29.76	30.18	30.53	29.59	30.09	30.57	29.37	1872
30.14	30.38	29.94	30.13	30.42	29.81	30.14	30.47	29.64	30.04	30.55	29.37	30.16	30.49	29.53	30.07	30.61	29.37	1873
30.09	30.27	29.85	30.14	30.36	29.90	30.17	30.50	29.78	30.16	30.53	29.31	30.19	30.72	29.77	30.12	30.74	29.31	1874
30.07	30.35	29.76	30.12	30.39	29.69	30.09	30.45	29.65	30.14	30.54	29.69	30.00	30.33	29.40	30.08	30.61	29.23	1875
30.13	30.27	29.91	30.06	30.26	29.80	30.05	30.42	29.66	30.03	30.32	29.61	30.10	30.44	29.58	30.08	30.63	29.43	1876
30.06	30.31	29.88	30.11	30.27	29.81	30.09	30.40	29.80	30.13	30.47	29.44	30.17	30.51	29.72	30.10	30.68	29.32	1877
30.01	30.15	29.88	30.17	30.48	29.9-	30.10	30.40	29.79	30.07	30.41	29.30	30.08	30.55	29.50	30.03	30.58	29.30	1878
30.06	30.26	29.74	30.15	30.40	29.57	30.18	30.69	29.78	30.15	30.53	29.65	30.12	30.49	29.64	30.11	30.69	29.53	1879
30.11	30.30	29.81	30.14	30.38	29.89	30.14	30.43	29.70	30.22	30.71	29.68	30.13	30.68	29.52	30.11	30.71	29.27	1880
30.10	30.28	29.91	30.09	30.31	29.60	30.16	30.41	29.79	30.14	30.62	29.73	30.16	30.52	29.68	30.10	30.62	29.27	1881
30.07	30.35	29.80	30.15	30.37	29.94	30.09	30.33	29.86	30.16	30.46	29.96	30.14	30.65		30.09	30.65	29.44	1882
30.14	30.32	29.97	30.12	30.44	29.76	30.15	30.55	29.49	30.17	30.68	29.70	30.12	30.44	29.62	30.11	30.69	29.49	1883
																		1884
30.09	30.40	29.74	30.13	30.54	29.57	30.12	30.69	29.49	30.11	30.71	29.30	30.12	30.72	29.28	30.08	31.15	29.01	Means and Extremes

A LATELY DISCOVERED METEOROLOGICAL CYCLE.

INTRODUCTION.

The following article is a prelude to a more extensive account of the results obtained during five years of continuous labor assiduously devoted to a search after meteorological cycles, which results I have thought of publishing soon. I publish this, hoping thereby to gain the encouragement of those working in the same field, and to profit by any suggestions which they might offer in regard to future work, should it be deemed worthy of such.

The numbers in the accompanying tables I and II are the monthly barometric means at Portland and St. Paul for the years given. They were taken from the annual "Reports of the Chief Signal Officer."

TABLE I.

Monthly Barometric Means.

PORTLAND, ORE.

	1874	1875	1876	1877	1878	1879	1880	1881	1882
December........	30.082	30.248	30.075	30.194	30.106	30.300	30.173	29.903	30.109
January..........	30.017	30.211	30.105	30.102	29.940	30.178	29.989	30.138	30.151
February	30.093	30.243	30.078	30.099	29.820	30.090	30.209	30.035	30.112
March	29.984	30.129	30.020	30.016	29.983	29.971	30.113	30.091	30.145
April	30.116	30.183	30 108	30.128	30.058	30.109	29.950	30.055	30.063
May.............	30.037	30.113	30.110	30.031	30.091	30.080	30.107	30.081	30.088
June	30.101	30.119	30.074	30.111	30.091	30.106	30.075	29.998	30.035
July	30.071	30.171	30.059	30.081	30.043	30.015	30.085	30.064	
August..........	30.065	30.161	30.072	30.037	30.043	29.960	30.033	30.015	
September.......	30.060	30.102	30.033	30.072	30.067	30.018	30.095	30.028	
October..........	30.096	30.051	29.966	30.124	30.185	30.090	30.169	30.052	
November........	30.030	29.972	30.133	30.087	30.161	30.084	30.307	30.217	
Year........	30.058	30.125	30.069	30.086	30.050	30.083	30.101	30.054	

TABLE II.

Monthly Barometric Means.

ST. PAUL, MINN.

	1874	1875	1876	1877	1878	1879	1880	1881	1882
December	30.045	30.050	29.855	30.115	29.995	30.052	30.078	30.103	30.094
January	30.073	30.214	30.014	30.092	30.003	30.064	29.919	30.131	30.111
February	30 082	30.114	30.022	30.120	29.905	30.082	29.939	30.104	30.004
March...........	30.080	29.940	30.018	30.021	29.838	29.987	30.002	29.957	30.044
April............	30 003	29.916	29.886	29.921	29.651	29.930	29.824	29.958	30.019
May	29.860	29.808	29.855	29.860	29.823	29.898	29.791	29.910	29.946
June	29.797	29.843	29.749	29.775	29.818	29.878	29.805	29 864	29.856
July	29.842	29.870	29.930	29.830	29.875	29.807	29.870	29.973	
August	29.892	29.855	29.885	29.857	29.811	29.842	29.905	29.953	
September........	29.908	29.953	29.948	29.848	29.905	29.965	29.916	29.875	
October..........	30 003	29.919	29.830	29 935	29.854	29.945	29.941	30.081	
November	29.951	30.020	29.971	29.987	29.977	29.992	30.096	30.047	
Year........	29.957	29.960	29.914	29.948	29.871	29.953	29 924	29.997	

The numbers in tables III and IV are the monthly rainfall variations from an average of a number of years in the sections of country given. Sections of country were chosen rather than single stations as probably giving much more reliable results and eleminating as nearly as possible all local influences.

The numbers were taken from Lieut. Dunwoody's "Tables of Rainfall and Temperature (Professional Paper No. X of the Signal Service).*

In order to ascertain whether any periodicity could be detected in the oscillations of the barometer or rainfall, curves were drawn from these numbers as well as from those of a number of other stations and sections.† In the curves representing the monthly oscillations of the barometer at several of the stations the annual cycle was very perceptible, but no other oscillations which seemed to occur at regular intervals could be detected.

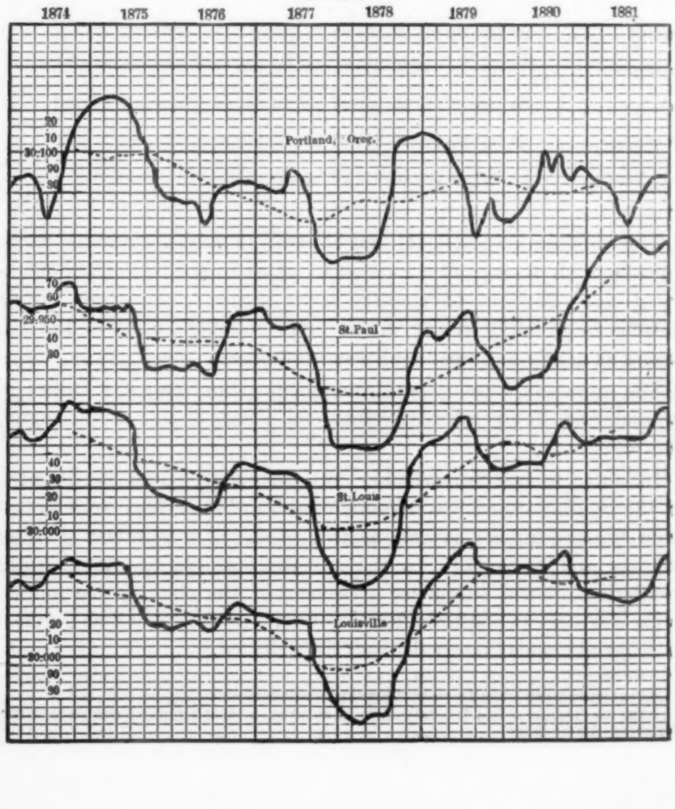
* I extended these tables from the "Monthly Weather Review."

† The results from only a few stations could be given in this article, so those most favorably situated were taken.

In order to eliminate this annual cycle and also as nearly as possible all the oscillations of shorter period, so that any oscillation of longer period which might exist would become apparent, the means of every consecutive twelve of these numbers were obtained. Column I in tables V and VI give the barometric means thus obtained. Column II, tables VII and VIII, give the rainfall means thus obtained, the sums being given in column I. Column III of this table gives the rainfall numbers still farther smoothed by getting the mean of each successive three of column II. Curves drawn from these numbers are given on plates I and II. The barometric curves are given on plate I, the ones under consideration being represented by the continuous lines. One of the most noticeable things in these curves is that, in the main, they all descend to about the year 1878, and then rise again. This is, very probably, the

PLATE I.

PRESSURE.



result of the eleven year cycle which has been found to exist in other countries, corresponding with the sun-spot cycle.* The curves, however, do not descend continuously, but in a series of undulations, and, what is most encouraging, the crests and depressions of these undulations appear to be separated by regular intervals of about two years from each other respectively.

On plate II, giving curves of the rainfall, these same two yearly undulations are found even more marked than in the barometric curves, since the oscillation of longer period is not so prominent. The undulations of these curves, as was to be expected, appear in opposite phase to those of the barometric curves. That we have here presented to us a true meteorological cycle I think can hardly be doubted since we are dealing with sections of country so widely separated, and covering almost the whole of the United States.

TABLE III.

Rainfall: Deviations from an average, in inches.

UPPER LAKE REGION.

	1875	1876	1877	1878	1879	1880	1881	1882	1883
December	−1.00	+ .50	− .30	+ .44	+ .98	+1.68	− .36	− .10	+ .26
January	− .45	+1.05	− .50	− .99	− .97	+1.08	+ .35	+ .33	+ .08
February	− .01	+ .95	−2.00	− .03	+ .45	+ .89	+3.09	+ .54	+ .85
March	+ .17	+1.70	+ .60	+ .18	− .84	− .90	+ .98	+1.61	−1.85
April	− .26	− .05	+ .30	+1.60	− .49	+1.49	−1.39	+ .70	− .53
May	+ .40	+1.45	−2.20	− .13	−1.43	+ .82	− .14	+ .80	+ .85
June	− .65	+1.35	+ .55	+ .61	− .25	+1.49	− .66	+1.39	+ .91
July	− .80	+ .60	− .16	+ .36	+1.24	+ .39	+ .12	− .66	+2.06
August	+1.25	+ .55	+ .73	− .83	− .77	+ .39	− .52	+1.34	−1.87
September	+1.10	− .40	+1.58	+1.64	+ .49	− .92	+2.79	−1.94	−1.20
October	+2.25	− .55	+3.11	+1.30	− .69	− .72	+3.24	+ .22	− .18
November	− .70	+ .80	+2.23	− .77	+2.50	− .28	+1.05	− .28	+1.00
Year	+1.30	+7.95	+3.94	+3.38	+ .22	+5.41	+8.55	+3.95	+ .33

* I take it for granted my readers are familiar with the investigations which have been made regarding this. If not, I would refer them to Smithsonian Report, 1881, and to *Nature*, vol. 28, Nos. 4 and 5, in which reference is given to the work of others, as well as interesting results obtained by Mr. Fred. Chambers, of India.

TABLE IV.

Rainfall: Deviations from an average, in inches.

OHIO VALLEY AND TENNESSEE.

	1875	1876	1877	1878	1879	1880	1881	1882	1883
December......	— .70	+ .50	—1.00	— .78	— .70	+3.72	— .83	+ .81	—2.35
January........	+ .65	+3.15	— .30	— .71	+1.05	+ .30	— .64	+ 5.96	— .15
February.......	— .49	—1.00	—2.90	—1.84	—1.05	+3.05	+1.15	+ 3.45	+2.20
March..........	+3.31	+2.20	+ .35	—1.58	— .71	+ .88	—1.82	+ 1.38	—1.26
April...........	— .76	—1.05	+2.45	+1.28	—1.39	+ .26	—1.20	— 1.19	+1.00
May............	—1.22	+ .77	—1.70	— .61	— .40	+ .47	— .63	+ 3.77	+ .65
June...........	+1.25	+ .70	+2.25	— .36	—1.39	— .17	— .40	+ .18	— .64
July............	+5.60	— .25	— .87	+ .57	.00	—1.69	—2.49	— 1.15	— .10
August.........	— .35	+1.20	— .04	— .18	+2.43	— .70	—2.60	+ 1.49	—1.09
September......	—1.00	+ .05	—1.03	+ .55	— .33	+ .33	+ .30	+ .06	—1.08
October.........	— .80	+ .50	+ .20	+ .83	— .86	+1.41	+1.48	— 1.30	+2.95
November......	+2.05	—2.00	+1.25	+ .07	+ .66	+ .92	+ .77	— .70	+ .61
Year.......	+7.34	+4.77	—1.34	—2.76	—2.59	+8.78	—6.91	+12.76	+ .74

The length of this cycle, as near as can be ascertained from the curves, is about twenty-five months.

This cycle having been ascertained by smoothing out the shorter oscillations of the barometer, it was endeavored by the same process to separate this cycle from the still longer oscillations of the barometer. In order to do this, the means of every twenty-four* consecutive monthly means were taken instead of twelve as before. By this means not only the smaller oscillations of the barometer were eliminated from the numbers, but also the twenty-five months' cycle, for, since within this time both the crest and depression of an undulation are included, the two neutralize one another. The numbers obtained by this method are given in column I, tables V and VI,

* It was more convenient to get the means of twenty-four at intervals of three months apart, and it made but little difference as far as the result desired was concerned. Twenty four months was also used on this account instead of twenty-five.

TABLE V.

PORTLAND, ORE.

I.	II.	III.	IV.	I.	II.	III.	IV.
	1874				**1878**		
30.080*				30.038	30.068	30.066	—.028
30.084				30.036			—.032
30.084				30.037			—.033
30.084				30.037	30.075	30.072	—.035
30.083				30.037			—.035
30.070				30.042			—.031
30.058	30.105		—.047	30.050	30.074	30.073	—.023
30.076			—.028	30.065			—.007
30.092			—.011	30.084			+.013
30.105	30.108	30.102	+.003	30.107	30.070	30.070	+.037
30.117			+.016	30 106			+.035
30.123			+.028	30.111			+.039
	1875				**1879**		
30.129	30.092	30.099	+.030	30.110	30.067	30.073	+.037
30.131			+.033	30.111			+.036
30.131			+.034	30.109			+.033
30.131	30.096	30.096	+.035	30.102	30.083	30.078	+.024
30.134			+.037	30.098			+.018
30.130			+.032	30.090			+.008
30.125	30.101	30.099	+.026	30.083	30.085	30.085	—.002
30.111			+.012	30.064			—.021
30.102			+.003	30.049			—.037
30.088	30.100	30.099	—.011	30.059	30.086	30.086	—.027
30.079			—.018	30.071			—.014
30.073			—.023	30.058			—.025
	1876				**1880**		
30.073	30.097	30.094	—.021	30.060	30.087	30.082	—.022
30.069			—.023	30.057			—.023
30.068			—.021	30.063			—.016
30.069	30.085	30.086	—.017	30.069	30.072	30.078	—.009
30.062			—.021	30.075			—.002
30.055			—.025	30.082			+.007
30.069	30.075	30.078	—.009	30.101	30.075	30.074	+.027
30.079			+.002	30.086			+.012
30.079			+.003	30.098			+.023
30.081	30.072	30.075	+.006	30.084	30.074	30.076	+.008
30.081			+.008	30.082			+.005
30.083			+.011	30.091			+.014
	1877				**1881**		
30.076	30.077	30.070	+.006	30.089	30.078	30.078	+.011
30.079			+.010	30.082			+.003
90.077			+.010	30.080			.000
30.074	30.062	30.065	+.010	30.079	30.082	30.082	—.003
30.077			+.014	30.078			—.010
30.090			+.030	30.063			—.022
30.086	30.057	30.058	+.028	30.054	30.087		—.033
30.079			+.020	30.072			
30.065			+.006	30.073			
30.042	30.055	30.060	—.018	30.079			
30.039			—.023	30.084			
30.033			—.031	30.085			

* The first figures given in this column at the beginning of each year represent the mean of the twelve months composed of the six months preceding and the six months following and including December of the previous year.

TABLE VI.

ST. PAUL, MINN.

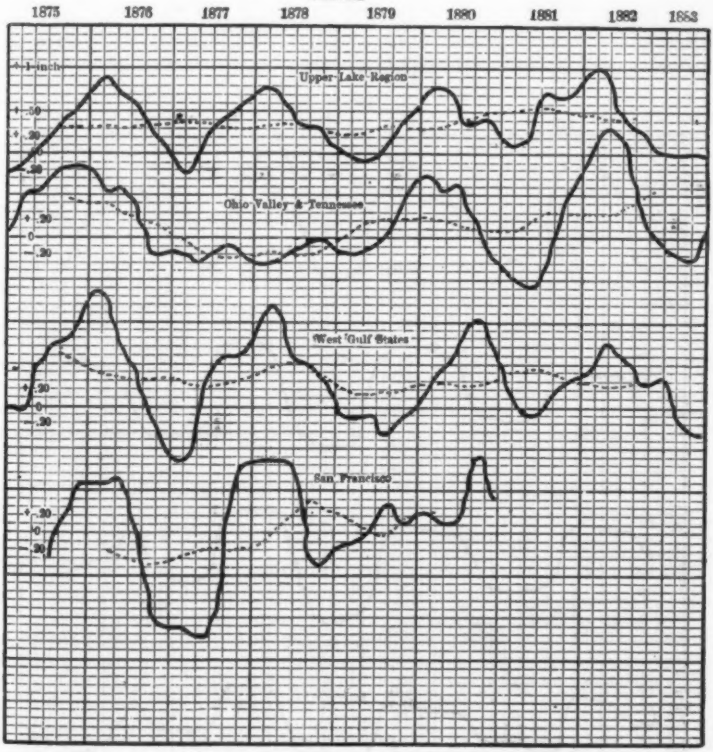
I.	II.	III.	IV.	I.	II.	III.	IV.
	1874				1878		
29.965				29.871	29.910	29.908	—.037
29.965				29.874			—.033
29.962				29.878			—.029
29.958				29.874	29.904	29.906	—.032
29.955				29.879			—.027
29.958				29.872			—.033
29.957	29.958		—.007	29.871	29.905	29.905	—.024
29.958			—.004	29.876			—.030
29.970			+.010	29.881			—.026
29.973	29.957	29.958	+.015	29.896	29.907	29.908	—.012
29.965			+.009	29.908			—.001
29.956			+.001	29.931			+.021
	1875				1879		
29.952	29.958	29.953	—.001	29.938	29.912	29.911	+.027
29.956			+.005	29.943			+.030
29.958			+.009	29.936			+.021
29.955	29.945	29.947	+.008	29.939	29.914	29.917	+.022
29.959			+.014	29.944			+.025
29.952			+.009	29.952			+.031
29.960	29.939	29.941	+.019	29.953	29.926	29.923	+.031
29.942			+.002	29.955			+.029
29.925			—.015	29.943			+.014
29.917	29.940	29.939	—.022	29.931	29.929	29.932	—.001
29.924			—.014	29.932			—.002
29.921			—.017	29.923			—.013
	1876				1880		
29.925	29.937	29.937	—.012	29.914	29.939	29.938	—.024
29.917			—.020	29.908			—.031
29.922			—.015	29.913			—.029
29.925	29.934	29.937	—.012	29.919	29.945	29.943	—.024
29.924			—.013	29.915			—.030
29.917			—.020	29.915			—.032
29.914	29.940	29.937	—.023	29.924	29.945	29.949	—.025
29.936			—.001	29.926			—.025
29.943			+.007	29.944			—.008
29.951	29.936	29.936	+.015	29.958	29.956	29.954	+.004
29.951			+.016	29.954			—.003
29.954			+.020	29.965			+.005
	1877				1881		
29.955	29.931	29.933	+.022	29.975	29.961	29.963	+.012
29.957			+.027	29.980			+.014
29.948			+.020	29.989			+.019
29.946	29.932	29.925	+.021	29.993	29.972	29.973	+.020
29.938			+.025	29.990			+.014
29.947			+.027	30.001			+.022
29.948	29.913	29.918	+.030	29.997	29.986		+.015
29.938			+.022	29.996			
29.930			+.017	29.994			
29.912	29.910	29.911	+.001	29.986			
29.897			—.013	29.993			
29.874			—.035	29.998			

for the barometer, and in column IV, tables VII and VIII, for the rainfall, only in case of the rainfall the numbers were smoothed by getting the mean of every three before getting the means of twenty-four. In order to still farther eliminate the minor oscillations, the numbers obtained by the process above described were in both cases smoothed by getting the means of three. These means appear in column III, tables V and VI, and in column V, tables VII and VIII.

From these means were drawn the dotted curves on plates I and II. Having thus separated the oscillations of longer period from

PLATE II.

RAINFALL.



the twenty-five months' oscillation, the numbers in column III, tables V and VI, representing the former were subtracted from the numbers in column I representing the combined oscillations of the

twenty-five months' cycle and that of longer period. The numbers in column V were in like manner subtracted from column III, tables VII and VIII. By this means the oscillations of the twenty-five months' cycle stand out alone. The results are given in column IV, tables V and VI, and column VI, tables VII and VIII.

Curves drawn from these numbers in the first two tables are given on plate III. These curves present the twenty-five months' oscillation of the barometer very decidedly. The twenty-five months' oscillations of the rainfall are so apparent in the curves on plate II that it was not deemed necessary to draw farther curves.

PLATE III.

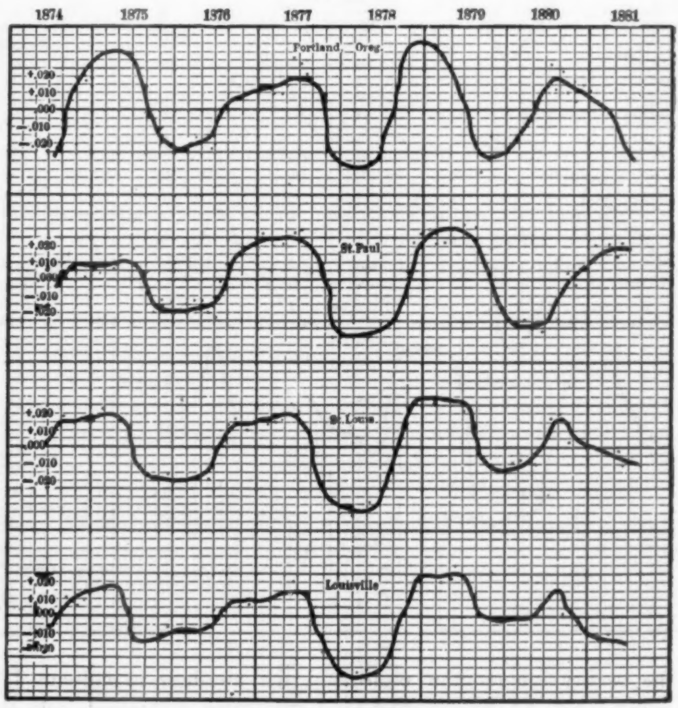


TABLE VII.

UPPER LAKE REGION.

I.	II.	III.	IV.	V.	VI.
		1875			
— .55	—.05*				
— 2.10	—.17	—.13			
— 2.20	—.18	—.13			
— .45	—.04	—.06			
+ .45	+.04	+.06			
+ 2.20	+.18	+.11			
+ 1.30	+.11	+.14	+.32		—.18
+ 2.80	+.23	+.23			—.10
+ 4.30	+.36	+.34			—.01
+ 5.26	+.44	+.45	+.40	+.36	+.09
+ 6.80	+.57	+.52			+.15
+ 7.00	+.58	+.60			+.33
		1876			
+ 8.05	+.67	+.69	+.37	+.38	+.31
+10.00	+.83	+.81			+.44
+11.40	+.95	+.89			+.53
+10.70	+.89	+.87	+.36	+.35	+.52
+ 9.20	+.77	+.73			+.39
+ 6.40	+.53	+.65			+.33
+ 7.95	+.66	+.60	+.31	+.33	+.27
+ 7.15	+.60	+.58			+.24
+ 5.60	+.47	+.43			+.08
+ 2.65	+.22	+.27	+.33	.+36	—.09
+ 1.55	+.13	+.17			—.20
+ 1.90	+.16	+.05			—.32
		1877			
— 1.75	—.15	—.07	+.45	+.38	—.45
— 2.55	—.21	—.22			—.60
— 3.31	—.28	—.25			—.63
— 3.13	—.26	—.21	+.36	+.38	—.59
— 1.15	—.10	—.05			—.41
+ 2.51	+.21	+.15			—.18
+ 3.94	+.33	+.31	+.32	+.31	.00
+ 4.68	+.39	+.36			+.05
+ 4.20	+.35	+.42			+.12
+ 6.16	+.51	+.45	+.26	+.30	+.15
+ 5.74	+.48	+.53			+.23
+ 7.04	+.59	+.61			+.30
		1878			
+ 9.11	+.76	+.70	+.34	+.32	+.38
+ 9.17	+.76	+.78			+.45
+ 9.70	+.81	+.75			+.40
+ 8.13	+.68	+.72	+.39	+.36	+.36
+ 8.19	+.68	+.63			+.27
+ 6.38	+.53	+.50			+.14
+ 3.38	+.28	+.38	+.35	+.36	+.02
+ 3.96	+.33	+.31			—.03
+ 3.98	+.33	+.34			+.08
+ 4.46	+.37	+.33	+.35	+.29	+.04
+ 3.44	+.29	+.26			—.02
+ 1.35	+.11	+.13			—.14

I.	II.	III.	IV.	V.	VI.
		1879			
+ .05	.00	+ .01	+.16	+.27	—.26
— .81	— .07	— .02			—.29
+ .07	+ .01	— .02			—.28
+ .13	+ .01	— .02	+.30	+.26	—.28
— 1.02	— .09	— .11			—.38
— 2.97	— .25	— .11			—.42
+ .22	+ .02	— .05	+.32	+.33	—.38
+ .90	+ .08	+ .12			—.20
+ 2.97	+ .25	+ .21			—.10
+ 3.41	+ .28	+ .27	+.36	+.30	—.03
+ 3.35	+ .28	+ .33			+.03
+ 5.33	+ .44	+ .45			+.15
		1880			
+ 7.58	+ .63	+ .62	+.22	+.30	+.32
+ 9.32	+ .78	+ .71			+.40
+ 8.47	+ .71	+ .78			+.47
+ 9.63	+ .80	+ .75	+.33	+.32	+.43
+ 8.22	+ .69	+ .74			+.40
+ 8.20	+ .68	+ .62			+.25
+ 5.41	+ .45	+ .48	+.41	+.30	+.09
+ 3.38	+ .28	+ .33			—.09
+ 2.65	+ .22	+ .30			—.14
+ 4.85	+ .40	+ .39	+.43	+.47	—.08
+ 6.73	+ .56	+ .42			—.06
+ 3.85	+ .32	+ .37			—.12
		1881			
+ 2.89	+ .24	+ .20	+.58	+.50	—.30
+ .74	+ .06	+ .11			—.40
+ .46	+ .04	+ .02			—.51
+ .45	+ .04	+ .09	+.50	+.54	—.45
+ 3.26	+ .27	+ .28			—.25
+ 7.22	+ .60	+ .53			+.01
+ 8.55	+ .71	+ .68	+.53	+.51	+.17
+ 8.81	+ .73	+ .72			+.21
+ 8.79	+ .73	+ .66			+.14
+ 6.24	+ .52	+ .61	+.50	+.52	+.09
+ 6.87	+ .57	+ .61			+.10
+ 8.96	+ .75	+ .72			+.22
		1882			
+ 9.90	+ .83	+ .86	+.53	+.49	+.37
+11.85	+1.00	+ .93			+.45
+11.17	+ .93	+1.01			+.54
+13.03	+1.09	+ .90	+.43	+.46	+.44
+ 8.30	+ .69	+ .74			+.29
+ 5.28	+ .44	+ .49			+.05
+ 3.95	+ .33	+ .38	+.41	+.43	—.05
+ 4.31	+ .36	+ .34			—.06
+ 4.01	+ .33	+ .35			—.03
+ 4.32	+ .36	+ .25	+.43	+.35	—.10
+ .86	+ .07	+ .18			—.17
— .37	— .03	.00			—.25
		1883			
— .32	— .03	— .04	+.20		
— .80	— .07	+ .02			
+ .92	+ .16	— .01			
— 1.29	— .11	.00			
— .55	— .05	— .08			
— .95	— .08	— .03			
+ .33	+ .03				

* The first figures given in this column at the beginning of each year is the mean of the twelve months composed of the six months preceding and the six months following and including December of the preceding year.

TABLE VIII.

OHIO VALLEY VND TENNESSEE.

I.	II.	III.	IV.	V.	VI.	I.	II.	III.	IV.	V.	VI.
		18	**75**					**18**	**79**		
— 1.15	—.10					— 1.61	—. 13	— .17	—.15	—.06	— .11
+ 1.12	+.10	+.20				— 2.64	—. 22	— .21			— .21
+ 7.05	+.59	+.41				— 3.21	—. 27	— .18			— .23
+ 6.40	+.53	+.54				— .60	—. 05	— .12	+.18	+.11	— .23
+ 6.00	+.50	+.54				— .48	—. 04	— .12			— .27
+ 7.10	+.59	+.57				— 3.17	—. 26	—· .17			— .36
+ 7.34	+.61	+.64	+.40		+.21	— 2.59	—. 21	— .11	+.30	+.23	— .34
+ 8.54	+.71	+.75			+.30	+ 1.73	+. 14	.00			— .24
+11.04	+.92	+.84			+.37	+ .98	+. 08	+ .21			— .04
+10.53	+.88	+.86	+.53	+.49	+.37	+ 5.08	+. 42	+ .35	+.22	+.26	+ .09
+ 9.42	+.79	+.81			+.33	+ 6.67	+. 56	+ .55			+ .30
+ 9.12	+.76	+.83			+.35	+ 8.32	+. 69	+ .67			+ .43
		18	**76**					**18**	**80**		
+11.11	+.93	+.86	+.55	+.48	+.38	+ 9.19	+ .77	+ .77	+.25	+.23	+ .54
+10.76	+.90	+.74			+.28	+10.41	+ .87	+ .79			+ .56
+ 4.91	+.41	+.61			+.17	+ 8.72	+ .73	+ .69			+ .45
+ 6.46	+.54	+.52	+.35	+.42	+.10	+ 5.59	+ .47	+ .57	+.23	+.24	+ .33
+ 7.51	+.63	+.63			+.26	+ 6.25	+ .52	+ .56			+ .34
+ 8.81	+.73	+.58			+.25	+ 8.52	+ .71	+ .65			+ .46
+ 4.77	+.40	+.46	+.36	+.28	+.18	+ 8.80	+ .73	+ .60	+.24	+.17	+ .43
+ 3.27	+.27	+.21			—.04	+ 4.25	+ .36	+ .46			+ .31
— .18	—.01	+.03			—.20	+ 3.31	+ .28	+ .26			+ .14
— 2.08	—.17	—.17	+.13	+.20	—.37	+ 1.41	+ .12	+ .11	+.03	+.10	+ .01
— 3.93	—.33	—.18			—.33	— 1.29	— .10	— .07			— .17
— .43	—.04	—.20			—.29	— 2.75	— .23	— .22			— .31
		18	**77**					**18**	**81**		
— 2.90	—.24	—.13	+.13	+.04	—.17	— 3.85	— .32	— .30	+.03	+.09	— .39
— 1.35	—.11	—.17			—.17	— 4.08	— .34	— .36			— .48
— 1.97	—.16	—.18			—.14	— 4.88	— .41	— .44			— .58
— 3.21	—.27	—.26	—.15	—.08	—.18	— 6.78	— .56	— .52	+.21	+.17	— .69
— 4.29	—.36	—.33			—.21	— 6.81	— .57	— .56			— .78
— 4.59	—.38	—.28			—.11	— 9.74	— .56	— .57			— .82
— 1.34	—.11	—.19	—.21	—.21	+.02	— 6.91	— .57	— .53	+.27	+.29	— .82
— 1.12	—.09	—.11			+.10	— 5.27	— .44	— .30			— .60
— 1.53	—.13	—.09			+.13	+ 1.33	+ .11	— .01			— .31
— .47	—.04	—.12	—.27	—.22	+.10	+ 3.63	+ .30	+ .32	+.40	+.30	+ .02
— 2.40	—.20	—.17			+.03	+ 6.72	+ .56	+ .48			+ .18
— 3.37	—.28	—.23			—.03	+ 6.88	+ .57	+ .69			+ .40
		18	**78**					**18**	**82**		
— 2.48	—.21	—.30	—.19	—.17	—.13	+11.24	+ .94	+ .83	+.24	+.29	+ .54
— 5.09	—.42	—.31			—.14	+11.82	+ .99	+1.01			+ .72
— 3.65	—.30	—.35			—.19	+13.16	+1.10	+1.18			+ .89
— 3.79	—.32	—.27	—.06	—.16	—.11	+17.25	+1.44	+1.32	+.24	+.29	+1.03
— 2.21	—.18	—.21			—.05	+17.00	+1.42	+1.35			+1.03
— 1.58	—.13	—.18			—.02	+14.22	+1.19	+1.22			+ .87
— 2.76	—.23	—.19	—.23	—.16	—.03	+12.76	+1.06	+1.01	+.39	+.38	+ .63
— 2.58	—.21	—.17			.00	+ 9.60	+ .80	+ .71			+ .30
— .82	—.07	—.09			+.09	+ 3.50	+ .29	+ .42			— .03
— .03	—.00	—.00	—.20	—.19	+.19	+ 2.24	+ .18	+ .15	+.52	+.49	— .34
+ .84	+.07	—.03			+.12	— .40	— .03	+ .10			— .38
— 1.83	—.15	—.07			+.03	+ 1.79	+ .15	.00			— .46
								18	**83**		
						— 1.33	— .11	— .05	+.56	+.45	
						— 2.15	— .18	— .13			
						— 1.10	— .09	— .20			
						— 3.68	— .31	— .27	+.28		
						— 4.82	— .40	— .26			
						— .57	— .05	— .14			
						+ .74	+ .06	+ .10			

To show that the temperature joined in the same march of the elements, it is only necessary to quote the following variations from the average temperature, taken from Lieut. Dunwoody's "Signal Service Table of Rainfall and Temperature."

	WINTERS OF					
	1874-5	1875-6	1876-7	1877-8	1878-9	1879-80
Upper Lake Region............	−21°.90	+12°.40	− °.30	+32°.00	− 1°.20	+13°.90
Ohio Valley and Tennessee.....	− 8.30	+22.10	− 3.80	+17.20	− 7.60	+25.10
West Gulf States..............	− 1.30	+16.10	− 7.90	+ 3.60	− 7.00	+19.10
South Atlantic States...........	− .10	+11.10	− 9.00	+ 3.60	− 4.00	+27.60

This shows conclusively that cold winters have occurred at the time when the oscillations of the barometer, as shown by the curves on the plates, were at a maximum and when the oscillations of the rainfall were at a minimum, and that warm winters have been the accompaniment of the opposite conditions.

When, however, the crests of the barometric curve and depressions of the rainfall curve fall in the summer the reverse seems to occur, for the dry summers are always the hot ones. This seems to prove that the oscillations of temperature are not the cause of the oscillations of the other elements, but that the temperature follows in the train as one of the effects of some general cause.

In the early part of the time under our consideration the crests and depressions of the curves representing the cycle occurred in the winter, but gradually advancing, by the latter part occurred in the spring and summer, as shown by the rainfall curves which reached a minimum in the spring and summer of 1881 and 1883. In the summer of 1881 there was a very destructive drought throughout almost the whole eastern part of the United States. In the summer of 1883 there was a destructive drought throughout the Gulf and South Atlantic States, and almost a drought over a large portion of the country in the eastern part of the United States.

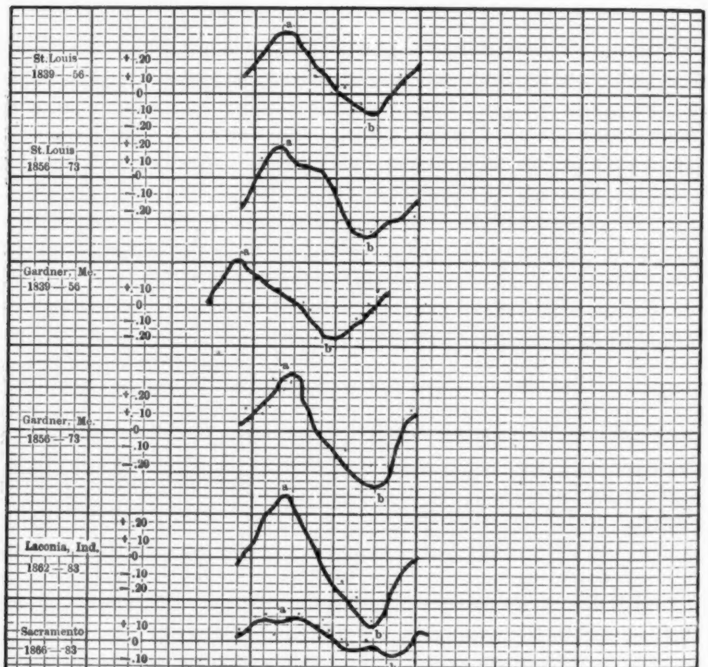
Having thus discovered these regular pulsations of the meteorological elements over the country during the last ten years, it was but natural to desire to ascertain whether they had existed during previous years over the country.

The only records of long period which could be obtained were rainfall records for St. Louis and Gardner, Me.,* beginning with 1839, and some tables of shorter period for Laconia, Ind., and Sacramento, Cal., taken from the Monthly Weather Reviews of Dec., 1882, and Jan., 1883.

It was found that by dividing the time into periods of seventeen years, and dividing these into periods of twenty-five and a half months, placing the corresponding months under one another, adding and dividing by the number of periods, then again getting the means of every consecutive twelve of the means thus found and constructing curves therefrom, a series of curves were formed which corresponded, in the times of their oscillation, with those

PLATE IV.

RAINFALL.



---

* The records for St. Louis were obtained from Prof. F. E. Nipher, being measurements made by Dr. Engelman; those for Gardner, Me., were obtained from R. H. Gardner, being observations made by himself and father.

found during the last ten years, except the curve found for Gardner, Me., for the time from 1839–56.

These curves are shown on plate IV; the crest of the undulations are marked *a*, and, in all except one, correspond to March, 1846, 1863 and 1880; the depressions are marked *b*, and correspond, all but two, to April, 1847, 1864 and 1881.

CONCLUSION.

In the foregoing article it has been shown that, during the last ten years in the United States, the barometer and rainfall have made a complete oscillation every twenty-five months. It has been farther shown that the cold winters which have occurred during the time have been coincident with the times of maximum height of these recurrent barometric oscillations while the warm winters have been the accompaniment of the barometric minima. Furthermore the most widely extended and destructive droughts have occurred when these regularly recurring rainfall depressions fell in the spring and summer.* Nor is this all of the evidence possessed by me in support of the existence of a twenty-five months cycle; but to attempt to elucidate all of the questions sprung and to give all the results of my investigation would have extended this article too long. One of these questions has no doubt already arisen in the readers min'd viz: why an undulation which appears in the other curves between the years 1877 and 1878 seems entirely absent from the curves representing the oscillations of the rainfall in the Ohio Valley and Tennessee.

Of the existence of two other meteorological cycles I have evidence equally as strong as that above given; in fact I think I have good grounds for asserting that what we know as the weather is composed of a number of meteorological cycles interacting among one another. I have been able, by combining into one curve, curves representing a series of cycles, to construct a curve almost precisely like one representing the actual oscillations of the monthly barometric means at Portland, Oreg., (the only station I have tried.)

I had hoped to be able to bring my work somewhat toward completion before publishing it but continued investigations have shown me that I have undertaken a work too immense to be easily accomplished by the feeble hands of one individual especially since I feel

* I think however that this is only one of the necessary concurrent causes of a severe drought.

that I must soon be hampered in my work by the necessity of a "struggle for subsistence."

I have devoted nearly the whole of the last five years to work in this line and I am satisfied that if I can gain assistance in this work not many more half decades will roll by before we shall be able to foreknow the coming weather, with considerable accuracy for long periods in advance.

MURFREESBORO, TENN., June 1, 1884. H. H. CLAYTON, JR.

EFFICIENCY OF LIGHTNING RODS.

Prof. Mohn of Christiana, Norway, having been employed by the government to investigate the efficiency of the protection afforded to buildings by lightning rods, seems to have substantially settled the much debated question, at least for that region of country. His report shows that light-house, telegraph station, and other exposed buildings, which were provided with conductors, did not by far suffer as much as churches, which in most cases were unprotected. It appears, in fact, that of about 100 churches reported to have been struck by lightning, only three were provided with conductors; that of these three the first had a conductor in good order, and the building was uninjured; the second had a conductor of zinc wire, which melted, and, of course, left the structure without protection; the third had a wire which was rusty where it joined the earth, and the church was burned. More than one-half the number of churches struck were totally destroyed. Mr. Preece, the English government electrician, states that no damage has occurred since telegraph poles were earth wired.—*The Electrician.*

AMERICAN METEOROLOGICAL JOURNAL.

AN ILLUSTRATED MONTHLY

DEVOTED TO SCIENTIFIC METEOROLOGY AND ALLIED BRANCHES OF STUDY.

W. H. BURR & CO., - Publishers and Proprietors.

100 Griswold Street, DETROIT, MICHIGAN.

—EDITED BY—

M. W. HARRINGTON,

Director of the Astronomical Observatory, Ann Arbor, Michigan.

PRICE,—IN THE UNITED STATES, ... $3.00 PER YEAR.
" IN COUNTRIES OF THE POSTAL UNION, ... 3.25 " "

AGENT FOR GERMAN AND AUSTRIAN STATES:

F. A. BROCKHAUS, LEIPSIG, BERLIN AND VIENNA.

The editor solicits communications on all subjects having any bearing on Meteorology. Correspondence on events of current interest, with the accounts of local newspapers concerning them, and all publications relating to American Meteorology will be welcome. Address all editorial communications to MR. HARRINGTON; all others to W. H. BURR & Co.

REVIEWS.

MODERN FRENCH METEOROLOGY.

The books which we note here are all published by a single Parisian house—that of M. Gauthier-Villars.

To begin with the smallest, we take up the *Annuaire des Longitudes* for 1884. It is an 18 mo. of 910 pp. Its predecessors come down in a series now approaching 100 and these little short and thick volumes have long been familiar to the writer and favorites with him. They contain an immense amount of tabular matter, astronomical, physical, chemical, financial, geographical and other; the tables are revised annually and come from the hands of entirely competent editors. A few of the tables are essentially French, but the most of them are cosmopolitan in character. Not the least attractive part of these annuals are the popular scientific sketches which take up a small part of each issue. They often come from the pen of M. Faye. The leading one this year is on the scourges of nature, and is written in M. Faye's most attractive vein. The second scientific sketch is by M. Janssen and relates to the French observations of the solar-eclipse of May 6, 1883 on the Caroline Islands. To those who already know this annual it needs no commendation, to those who do not we are sure we are doing a favor by recommending it to them.

The *Annuaire mèteorologique de Montsouris* is a book of the same form as the preceding and has 602 pp. The issue for this year is the thirteenth. It contains a calendar and some general meteorological tables, but is for the most part devoted to a report of the work for the year of the meteorological observatory under whose auspices it is published. The observatory of Montsouris is supported by the State, and is under the direction of M. Marié-Davy. It is in the park of Montsouris on the south side of Paris adjoining the fortifications, and occupies a fine Moorish building, originally made for the exhi-

bition of 1867 for the residence of the Bey of Tunis and removed to this place after the exhibition. Since its formal establishment in 1871 as a government observatory, this institution has done notable work for meteorology. Its field is one not much cultivated in this country, viz:—the relations of meteorology to agriculture and hygiene. The amount and value of its work can be judged by the thick little annuals which form its yearly reports.

The volume before us contains an interesting article on actinometry to which subject this institution pays much attention. The research is in several lines, the most notable being the usefulness of the rays of light and heat in foreseeing the weather, the relative amounts of the solar rays received directly from the sun and from the sky, and direct measurements of solar radiation. The relations of the cultivation of wheat, the vine, the beet etc., to meteorology receive considerable attention, and the analyses of air and water are carefully pursued. Not the least interesting part of the book is that of 139 pages, devoted to atmospheric fungi and bacteria. The tabular matter is scattered richly through the book and is accompanied by simple and attractive text. The matter relates more especially to Paris, but the point of view of the reporters is a general one and any student of the subject will find the volume full of interest.

As these volumes are published with the assistance of the government, their cost to the buyer is very small. The annual of the longitude bureau costs in Paris only a franc and a half (30 cents,) that of the observatory of Montsouris only two francs (40 cents.)

Popular works on the prediction of the weather are not rare in France and the four before us are fortunately all written by competent meteorologists. M. Radau's *Météorologie nouvelle et la prévision du temps* we have already noted on page 87 of this JOURNAL. M. W. de Fonveille's "*La prévision du temps*" dates from 1878. It is a 12mo of 102 pp., and is devoted largely to a sketch of the history of modern weather-prediction. The part America played in this history is not overlooked, though it is, we think, not sufficiently appreciated. Some account is given of the predictions of the New York *Herald*. Those of our readers who have not taken the pains to inform themselves of it on the ground, can scarcely realize the estimation in which the *Herald* is popularly held abroad. Its predictions are generally known in France, even more than elsewhere, and their general accuracy has given the *Herald* there a place in the popular mind occupied by nothing else American. In the latter part of the book are some useful rules as to the interpretation of weather-maps and changes of the barometer.

M. André Poëy's "*Comment on observe les nuages pour prévoir le temps* (3rd edition, 1879, 8vo, 172 pp. 17 chromo litographs and 3 woodcuts,) has a misleading title. One should apply to it, not for weather-lore but for a dissertation on clouds. The author began his studies of clouds upwards of 30 years ago and seems to have continued them ever since. He has carried them on in Europe and America and has published his views of cloud forms in the Smithsonian annual for 1870, where it has become familiar to American students. The peculiar views of the author are more fully developed in this book which is largely devoted to their forms but also takes into consideration their quantity, progressive and azimuthal motion, and nature. The last chapter is devoted to experimental and synthetic considerations on their structure and form.

M. Poëy has continued his studies in a later volume—*Les courants atmosphériques d'aprés les nuages au point de vue de de la prévision du temps* (1882, 8vo. 86 pp.) This volume is a supplement to the preceding and, like that, is rather a contribution to the literature of clouds than to that of winds or of weather-prediction. It is in part controversial and the author takes pains to point out the

official neglect of clouds, to which subject an entire chapter is devoted. He seems however to overlook the real cause of this neglect, and that is that there is no satisfactory and simple plan for cloud observation which can be entrusted to observers generally with hopes of good results. Much advance has of late years been made in the subject to which M. Poëy has contributed his share. But the photographic method is laborious and expensive and requires more special training than ordinary meteorological observers possess. The relations of clouds to other meteorological phenomena are more fully discussed in this volume than in the preceding, and especial attention is directed to their motions. The two books together form a valuable contribution to cloud literature and must be read by every student of the subject. Their value is materially increased by bibliographical lists, which are fairly full in each volume.

Professor E. Mascart is director of the French Central Meteorological Bureau and his *Météorologie appliquée a la prévision du temps* (1881, 18mo., 60 pp., 16 colored maps) could be expected to be a model and such it proves to be. It is the report of a lecture by M. Mascart delivered to the Superior School of Telegraphy and is a plain and simple account of weather-maps and how they are to be used.

M. Radau is a prolific writer and the elegance of his style and the trustworthiness of his scientific attainments are sufficiently vouched for by the fact that he is a contributor for the *Revue des deux mondes.* In a small volume of the series called *actualités scientifiques,* (1880, 8vo., 58 pp.,) we have two articles by M. Radau, apparently republished from some journal. The first is entitled, *Le rôle des vents dans les climats chauds,* and is a discussion of some points of comparative climatology, apropos of Pauly's work on this subject. The second is entitled, *La pression barométrique et les climats des hautes régions.* It is a discussion of the physiological effects of a change of atmospheric pressure and is written apropos of the books of Bert and Jourdanet on this subject. The articles are in a very popular vein and presuppose no previous knowledge on the part of the reader.

The periodical popular scientific literature is represented by the journal *L'Astronomie,* which is attractive in matter, in typography, and in illustrations. It is conducted by M. C. Flammarion, than whom perhaps no one has been more successful in bringing the facts of physical science (even the most abstruse) within the range of popular comprehension. *L'Astronomie* is especially devoted to the science whose name it bears, but it also pays attention to meteorology and physical geography. These lines of study are inseparably connected, and in looking over the tables of contents of the first two volumes which lie before us, we find meteorology has not been neglected. The journal, like all the work of M. Flammarion, is especially characterized by its graphical representations. Ideas, difficult to seize, are pictorially represented and become so easy and suggestive that we wonder that there was any difficulty in them.

The French are frequently accused of neglecting the scientific literature of other nations. We think it is a mistake. The reception of valuable foreign work by their Academy of Science, is always warm and sympathetic and in the two volumes lying before us, we have farther proof of their appreciation of foreign literature. The first is a translation by MM. Zurcher and Margollé (themselves authors of many popular meteorological works) of Scott's "Weather Charts and Storm Warnings." The translation is a deserved compliment to a deserving book. The second volume is a translation of the first nine of Professor Loomis' papers in the *American Journal of Science.* The papers gain in interest in being brought together and here form an 8vo. volume of 244 pp. The latest paper of Professor Loomis is the twentieth so that if all were collected together they would make

a volume twice as thick. They make altogether an extremely valuable contribution to meteorology, and it is a proper source of American pride that they are among America's valuable additions to the science, and that they are sufficiently appreciated abroad to be considered worthy of collection and translation.

In the series of books which we have noted we have a fair illustration of French activity in meteorological literature. The works are uniformly characterized by neatness in typography, illustration, and arrangement, and by elegance and perspicuity of style and, when the matteradmits of it, they are also characterized by vivacity. These are the French literary characteristics and to them it is due that French scientific literature is always agreeable reading and its authors succeed in making even abstruse subjects plain and easy. We have in mind a treatise on elementary analytical mechanics (Delaunay's) which makes an exceedingly difficult subject, not only easy, but attractive. But it does not follow that what is gained in simplicity is lost in accuracy or precision. We do not sympathize with a current notion, (recently published in *Science*) that French science is of a low order. On the contrary we believe the French are adding their part to the world's knowledge and are doing it with the vivacity and attractiveness which are their national traits.

LITERARY NOTES.

—The *Illinois Crop Report* No. 112 gives the meterological conditions for May from 27 stations.

—The *Michigan Crop Report* No. 32. contains a meteorological summary of reports from 29 stations for April.

—The *Tennessee Crop Report* for May contains the report of the weather service. Heavy rainstorms and some floods are reported.

—Mr. T. Brainerd Hall publishes monthly an abstract of meterological observations at Worcester, Mass. The publication is made in the Worcester *Evening Gazette* and appears promptly at the end of the month.

—In the current number (June and July) of the *Kansas City Review* Mr. Warren Kraus gives some interesting notes on "Some older tornadoes." This Journal usually contains articles and items interesting to meteorologists.

—We have received from Mr. C. L. Prince, F. R. Met, etc., the summary of observations at his observatory, Crowborough, Sussex, England, for 1883. Mr. Prince, in his report, makes some remarks on the phenomenal sunsets.

—The *Monthly Weather Review* of the Signal Service for April has introduced the improvement of combining the paths of the low-barometer areas over the United States and the Atlantic into one double map, and the map has a more attractive appearance. Only seven low areas were noted and their paths were unusually crooked.

—Professor Loomis' twentieth contribution to meteorology appeared in the July number of the *American Journal of Science*. It treats of the reduction of barometic observations to sea-level. The general conclusion is that the search for a formula which will enable us to make this reduction under all circumstances is hopeless.

—The *Pilot Chart* of the Hydrographic Office for July reached us promptly on the 4th. The ice continued its unusual southern extension during June. A berg was observed near lat. 40° in long. 50° W, and just north of this the ice occupied an extensive territory. Seven waterspouts are noted, all but one in the West Atlantic betwen the West Indies and Delaware Bay. The remaining one was just east of the Azores.

—The report of the *Alabama Weather Service* for May is at hand. It has reports from 29 stations of which three belong to the Signal Service, that of Chattanooga being in Tennessee. The report contains a map of precipitations and isotherms for the month. There were no special phenomena of interest.

—No. 61 is the latest publications of the English Meteorological Council and is entitled *A Barometer Manual for the use of Seamen*. It is a pamphlet of 42 pages and is a simple and plain account of barometers and air-pressure. The variations of the latter and its relations to weather and storm are clearly pointed out. It is illustrated by four maps and several cuts. It must serve a good purpose in giving seamen plain and correct information on the subjects treated.

—Liznar's *Anleitung zur Messung und Berechnung der Elemente des Erdmagmagnettsmus* (Vienna, 1883, 8vo, 79 pp.) lays no claim to originality. The professed intention of the author is to give the necessary rules for observation and formulas for reduction with all possible clearness and brevity. He omits matter (such as the astronomical determinations of azimuth and time) which can be easily found elsewhere. The author seems to have closely hit the golden mean between injurious brevity and unnecessary fullness and his little treatise will prove a useful accessory to the library of every magnetical observatory.

—We owe a copy of the annual report of the Paris Observatory for 1883 to Professor Payne of the *Sideral Messenger*. The magnetic observations are carried on at this institution by M. Wolf who, in the last months of the year, installed in some new subterranean rooms the instruments of Gambey, Lambert, and Mascart. A new anemometer, invented by M. Eug. Bourdon, has been recently put up. The force of the wind is multiplied twenty times by causing it to pass through a biconical tube which makes part of the vane. The instrument is figured in detail in this report.

—We have received the *Reports of the Ohio Met. Bureau* for April and May. They are substantial pamphlets of 64 and 47 pp. and contain the daily means from 38 stations. The monthly rainfall is represented graphically. The report for April contains an account of the Jamestown tornado (April 27, 1884) which we hope to be able to reprint.

—The *Official Report of the Relief Furnished to the Ohio River Flood Sufferers by the U. S. Relief Boat Carrie Caldwell* (Evansville, 1884. 8vo, 78 pp.) is less pretentious but more satisfactory than the preceding. In addition to the report it gives some general account of the flood. The "Carrie Caldwell" furnished relief between Evansville, Ind., and Wickliffe, Ky. The latter place is just below Cairo and in this short distance, which includes no large city, this boat distributed 321,860 rations in Feb. and March. This was not the total relief afforded as the Red Cross Society and private charity did much. This report is made Dr. R. P. M. Ames the Surgeon in charge.

—The *Report of the Meteorological Council of the Royal Society*, for the year ending March 31, 1883, has been received. The total expendure for this service for the year was about $78,000 of which Parliament gave $76,500. The cost was about $1600 more than for the year before. The Council undertakes many special researches. About $4,000 were expended in them in this year as against about $5,000 in the year before. The percentage of success in forecasts was 79, an improvement of 1 per cent. over the year before. The lowest percentage was 74 in the South of Ireland, and the highest 83 in the South of England. Forecasts are issued both for the day from noon to noon and for the day of daylight. The automatic records are mechanically reduced by means of Sir William Thomson's harmonic analyser which is found to give sufficient accuracy. The literary actvity of the service is very great. The latest publication bears the current number of 61.

—*The Great Flood of 1884 in the Ohio Valley* (Gallipolis, 1884, 8 vo 137 pp.) is a somewhat melodramatic pamphlet and contains surprisingly little of general interest. It was edited by John D. Vance and seems intended rather as a memento of the work of the Gallipolis Relief Committee than as a history of the "Great Flood." The work of this committee deserves a memorial but we think the history of the flood still remains to be written.

—We have received the current numbers of two new German meteorological publications, both monthlies. The *Meteorologische Zeitschrift* of the German meteorological society is a large 8vo of 48 pp. It began nominally with the year but the first numbers were somewhat belated. It contains many important articles and bids fair to prove one of the most important meteorological publications of the world. It is edited by Dr. W. Köppen of Hamburg. The second is a smaller journal (about the size of this JOURNAL but not so thick.) It is named *Das Wetter* and its purpose is evidently more popular than the preceding. Its first appearance is that of a double number for April and May. It is published by Dr. R. Assmann of Magdeburg, and is the organ of the Magdeburg branch of the German society. While of a generally popular character the articles in this number are far from trivial. On the contrary they are of real scientific importance and the difference between this journal and its larger twin-brother is rather that of size and tone than that of scientific importance. It is an interesting fact that three meteorological journals (the two mentioned above and the AMERICAN METEOROLOGICAL JOURNAL) came into existence at about the same time. It is an omen of more general and more intelligent interest in scientific meteorology.

CORRESPONDENCE.

ELECTRIC POTENTIAL AND GASEOUS PRESSURE.

TO THE EDITOR:—I was glad to have my attention called, by your correspondent H. H. Clayton, Jr., in the June number of this journal, to the instances where sudden barometric fluctuations have accompanied thunder-storms. Since writing the article in the May number, I find that the mention of sudden barometric disturbances is by no means rare in English meteorological journals, and that their peculiar character and possible causes have been considerably discussed, there being with some a belief that there is something in these fluctuations peculiar to and characteristic of almost every kind of weather. In fact, it is stated by one observer (I have not the exact reference at hand) that he could tell from simple inspection of his barograms whether it had been raining, snowing or hailing.

I have found, however, thus far no reference to what may be the exact connection, if any, between atmospheric electricity and barometric pressure, but it seems to me that this is well worth careful investigation, and we shall await with interest the data which Mr. Clayton has collected as bearing upon the question.

In this connection there are one or two mechanical and physical questions involved which it is well to have clearly understood and stated at the outset as a basis for further intelligent discussion.

In the first place, as commonly accepted by physicists to-day, the *pressure* of a gas upon any bounding surface—and this is what the barometer measures—is due to the bombardment of that surface by the freely moving atoms or molecules of the gas, and depends in amount upon the energy—normal to the surface—and upon the frequency per unit of area of these

individual impacts. Such pressure may then be modified in two ways :—First, by varying the energy of impact of the individual molecules, as when a change of temperature takes place in the gas; and second, by a change of density, or mass per unit of volume, in the gas, which will change the frequency of impact per unit of area. One or the other, or a combination of both, of these changes would be the only way of varying the pressure of a gas, which would be unanimously agreed to by physicists to-day.

With this as a hypothesis, I cannot quite accept, without some modification or further extension, the theory set forth by Mr. Clayton in these words (p. 76):—"If there be an increase or decrease of "attraction between the earth and any "part of the atmosphere at such a time, "it must certainly make itself felt by an "increase or decrease of pressure, how-"ever minute, at the earth's surface im-"mediately under such a body of air or "vapor, and any variation of potential "must make itself felt by a variation of "pressure."

Now the elastic atmosphere cannot directly transmit a pressure or stress as a solid body does, and the only way (still sticking to the above hypothesis)in which a varying attraction between earth and cloud could change the atmospheric pressure at the earth's surface would be by setting up a motion, continuously accelerated, of the whole mass of cloud to or from the earth, piling up the air in front or drawing it away behind the cloud—before there is time for it to flow out from under or in from the sides to restore equilibrium—thus increasing or decreasing the density, and consequent frequency of molecular impact, at the earth's surface.

This effect would be very similar to that produced by the wind wherever it meets with any resistance, especially against the walls and irregular roofs in a large city. This effect is plainly shown on the record of a sensitive barograph when the wind is blowing, but, in examining that of the most sensitive one in the Signal Office at Washington, I find that in very high winds the increment of pressure from the strongest gusts rarely exceeds about half a millimetre of mercury. (The barographs there are in the upper [fourth] story of the building, but it is not probable that the increase of pressure would be very much greater nearer the ground.) This effect from our most violent surface winds is so small compared with most of the rapid fluctuations described in my paper, that I had rejected the idea of accounting for these through any increase of pressure due to simple energy of air in motion; but perhaps in this I am wrong. We know that rushing gusts of wind frequently precede approaching thunder-clouds, and, if these are caused by air driven out from under a cloud that is being rapidly dragged towards the ground, then the pressure would be greatest directly under the centre of the cloud, though the wind there would not blow at all. The situation would be the same in the case suggested on page 25 of my paper, in the 1st question there. If through mutual attraction or repulsion the clouds were piled up over any region so that gravity, acting on a greater mass, increased the density and pressure below, this increase would tend to start winds blowing out from under to regions of less pressure, and thus the effect at the earth's surface would be about the same whether we suppose vertical or horizontal accelerating forces acting upon the clouds. In either case, considering how slight is the effect of the most violent gusts in our ordinary storms and high winds, I am still disposed to think that the small variations of pressure due directly to the energy of air in motion are insufficient to account for the amount and suddenness of the barometric fluctuations referred to.

There is another possible cause of some of these short waves in the pressure curve, which deserves careful investigation. I refer to the passage overhead of whirlwinds—miniature tornadoes—in the upper regions of the air, and their probable effect on the pressure below. Here we have cyclonic action, where centri-

fugal inertia combined with energy of rotation tend to sweep the air out from the whirling centre and to bore a funnel-shaped depression down through the horizontal strata, like what we see in running streams, and like the funnel-shaped tornado-cloud so often described. Professor Ferrell's thorough mathematical investigation of this phenomenon showed that this funnel-shaped cloud surface must be approximately a surface of equal pressure, marking the dew-point for that particular temperature, pressure, and hygrometric state of the air; and, no doubt, a barometer passing through the centre of one of our western tornadoes would exhibit, to an observer who could remain in its vicinity long enough, some lively travelling of the mercury column or of the pointing-hand down and up again. We can picture to ourselves some enthusiastic meteorological observer grasping an aneroid and rapidly taking readings while he is swiftly whirled round over the ground or through the air by a tornado, but fear that it will be a long time ere this can be realized.

Now supposing this whirlwind, on a smaller scale perhaps, to be some distance overhead, the question arises: What will be the form of the isobars as we descend below the end of the whirling funnel and away from its sides? I know of no mathematical investigation bearing upon this point, but we do know that the *destructive winds* do not reach very far below it, for, when the funnel rises from the ground, its injurious force there suddenly ceases till it comes down again, often miles away; and this, together with the flattened bowl-like shape often assumed by the base of the whirling cloud, would seem to make it almost certain that these steep funnel-shaped isobars must be very rapidly flattened and smoothed out into gentle undulations at a short distance below the base of the cloud; or, at least, that so far as they do extend downwards in the shape of such sharp waves as those shown on page 19 for Dec. 24 and 27, then we should expect brisk whirling winds to accompany them, if they are caused by passing whirlwinds overhead.

I have not yet had time to investigate the connection of these barometric waves with sudden changes in the velocity and direction of the wind, but I hope, through the courtesy of the officers of the Signal Service, to do this thoroughly as soon as I can find the leisure, the continuous records of the self-recording anemometers and anemoscopes (wind-vanes) offering every facility for such comparison. I can say, however, from a hasty comparison in a few cases, that there are one or two instances on record of quite sudden sharp fluctuations in the pressure curve when there was only the lightest possible breeze moving, and the vane of the anemoscope scarcely swung at all for some hours before, during, and after the barometric disturbance.

The apparent difficulty of accounting for many of these fluctuations by any direct action of air in motion, and the sharp cusp-like points in many of the curves—indicating an almost instantaneous reversal in the increment of pressure—led me to advance the idea set forth in my 3rd question, p. 26, viz:—Whether there may be a direct connection, however slight, between *electric potential* and *gaseous pressure*, so that a discharge between clouds or between earth and cloud might account for the instantaneous reversal of the increment of pressure.

By this possible connection between electric potential and gaseous pressure I do not mean any change in density—*i. e.*, in the frequency of molecular impact per unit of area—accompanying a change of electric potential upon any body in the neighborhood, nor any change in the *average* energy of motion of the individual molecules; but my point is, whether it is possible that this motion may be slightly *polarized* in some way with reference to the *lines of force*, so that the average energy of impact normal to an equipotential surface, for instance, might be slightly different from that normal to a surface at right angles to this. The possibility of this does not seem to me to be

a violent assumption; nor, on account of our ignorance of what is the exact nature of electricity and magnetism, would it, perhaps, be going too far to ask whether even the *average* energy of gaseous molecular motion might not be slightly changed by the developement of, or change in, electric potential upon some neighboring surface; but perhaps the phenomenon of polarization alone, if it could be shown to exist, would be sufficient to account for all the phenomena, the amount of polarization being supposed to increase with the increase of potential.

It seems to me that this question is worth the attention of physicists, and I would call attention to the other few remarks I made upon the subject on page 26 of my first paper.

H. M. PAUL.

WASHINGTON, 1884, July 4.

TO THE EDITOR:—On page 109 of this JOURNAL Mr. Hazen, in his reference to the curve on page 25 of my article, has slightly mistaken its significance. The maximum at 8^h or 9^h (3^h or 4^h of the local time) is not a maximum of *pressure*, but a maximum of *disturbance* or of sudden fluctuation in the pressure, whether up or down. And likewise the minimum at about 20^h or 21^h indicates that, for the dates under consideration, the barometric curves were, on the average, the *smoothest* for that time of a day (15^h or 16^h of the local astronomical time.) This particular significance of the curve was, I see, not stated quite so clearly as it should have been on page 24 and 25 of the article, and hence I take this occasion to set forth its meaning more clearly.

H. M. PAUL.

WASHINGTON, July 21, 1884.

PUBLISHERS' DEPARTMENT.

Sergt. J. P. Finley, whose excellent article on Tornado predictions, published in the July number of this JOURNAL, was read with so much interest, has received a well deserved promotion and now writes his name Lieut. Finley.

The number of those who have acknowledged the "sample copies" of the AMERICAN METEOROLOGICAL JOURNAL which have been mailed to them, by remitting for a yearly subscription, is such as to be very gratifying to the publishers, and a continuance of such acknowledgements will be thankfnlly received. The JOURNAL has come to stay,—all may be assured of that, and material assistance from its friends at this stage of ist existence will be especially appreciated. The additional assurance is given that the JOURNAL will be enlarged and otherwise improved as rapidly as its patronage will warrant, the intention being to make it thoroughly representative of American Meteorology.

The *Detroit Free Press* by a combination of excellent editorial management and commendable enterprise in its business department, has acquired a reputation for first class journalism which has not only become national but has extended across the water. It combines the solidity of current news with enough lighter reading to give variety and piquancy to its pages and to make of it a desirable family paper. The success of its enterprise is attested by its very large and growing circulation.